COMPONENT PART NOTICE

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THE COMPONENT PART IS PROVIDED HERE TO ALLOW USERS ACCESS TO INDIVIDUALLY AUTHORED SECTIONS OF PROCEEDING, ANNALS, SYMPOSIA, ETC. HOWEVER, THE COMPONENT SHOULD BE CONSIDERED WITHIN THE CONTEXT OF THE OVERALL COMPILATION REPORT AND NOT AS A STAND-ALONE TECHNICAL REPORT.

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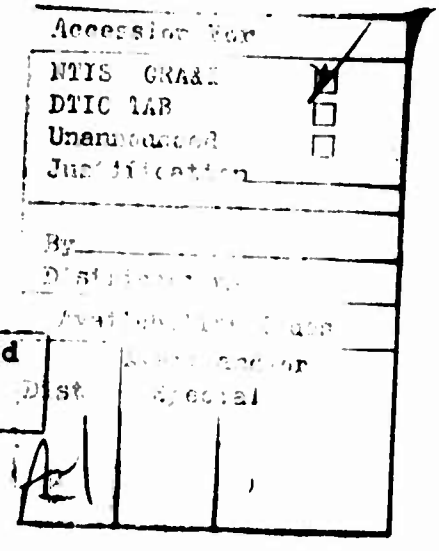

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EXPLOSIVE SAFETY CRITERIA AT A DEPARTMENT OF ENERGY CONTRACTOR FACILITY

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ABSTRACT

Monsanto Research Corporation (MRC) operates the Mound facility in Miamisburg, Ohio, for the Department of Energy. Small explosive components are manufactured at MRC, and stringent explosive safety criteria have been developed for their manufacturing. The goals of these standards are to reduce employee injuries and eliminate fenceline impacts resulting from accidental detonations. This paper will describes the manner in which these criteria were developed and what DOD standards were incorporated into MRC's own design criteria. These design requirements are applicable to all new construction at MRC. An example of the development of the design of a Component Test Facility will be presented to illustrate the application of the criteria.

*Mound is operated by Monsanto Research Corporation for the U.S. Department of Energy under Contract No. DE-AC04-76DP00053.

DEPARTMENT OF ENERGY (DOE) EXPLOSIVES SAFETY STANDARDS

The DOE has developed a "DOE Explosives Safety Manual," DOE/EV/06194-2, that contains explosives facility design criteria. Paragraph 6.4 of that document, titled "Explosive Facility Siting and Design Criteria," is reproduced below.

6.4 Explosives Facility Siting and Design Criteria

In addition to this manual, the following are resource documents for the siting and design of explosives facilities:

- DOE Order 6430 - Department of Energy General Design Criteria Manual, Chapter XXII
- TM 5-1300 - Structures to Resist the Effects of Accidental Explosions
- DOE/TIC-11268 - A Manual for the Prediction of Blast and Fragment Loading of Structures
- DOD 5154.4S - Department of Defense Ammunition and Explosives Safety Standards
- TR-828 - Blast Environment from Fully and Partially Vented Explosions in Cubicles
- AD 411445 - Industrial Engineering Study to Establish Safety Design Criteria for use in Engineering of Explosives Facilities and Operations
- AFWL-TR-74-102 - The Air Force Manual for Design and Analysis of Hardened Structures

- HNDM-1110-1-2 - Suppressive Shields, Structural Design and Analysis Handbook.

As can be seen, some of the principal DOE design criteria are military references. This makes alot of sense. Why re-invent the wheel? This DOE manual evolved over the past five years and was co-ordinated by DOE Headquarters, Washington, D.C. A Manual Committee, which includes representatives from many DOE internal and contractor facilities, meets twice a year and constantly up-grades the manual. Mound has a representative on that committee.

The Manual Committee intends to form a sub-committee dealing with facility design criteria only. The present manual deals with the entire subject of explosives safety with emphasis on operational safety. The idea of the Design Criteria Sub-Committee would be to exchange information among facility designers and design reviewers, many of whom are at this seminar.

MOUND'S EXPLOSIVES FACILITY DESIGN CRITERIA

MRC operates the Mound site for DOE in Miamisburg, Ohio, a suburb of Dayton, Ohio. Because Mound is situated on a 300-acre site, within the city limits of Miamisburg, we are particularly sensitive to our neighbors' reactions to any planned or accidental detonations. This sensitivity affects our explosive facility fenceline design criteria.

Accordingly, to avoid any "temporary threshold hearing shift" in any person who might be at our fenceline, we site Class I and Class II explosive operations (the more dangerous operations) so that a temporary hearing shift will not result if an accidental detonation should occur. We do not want any detonation pressure pulses to exceed 0.2 psi at our fenceline.

These facilities will be sited according to the equation:

$$D_1 = 100\ W^{1/3}$$

where "D_1" is the distance from the fenceline, in feet, of a Class I or II operation containing "W" (pounds) of explosives. "W" is the TNT equivalent weight of the explosives in the process.

For example, an operating facility processing 10 lb of H.E. would have to be:

$$D_1 = 100\ (10 \times 1.3)^{1/3}$$

1.3 is used to convert our typical H.E. to TNT.

$$D_1 = 100\ (13)^{1/3}$$

$$= 100\ (2.35)$$

= 235 ft from the nearest fenceline.

For Class III operations (low risk storage facilities), we do not want an accidental detonation from a Class III area to cause broken windows at the fenceline.

Because we want to avoid generating 0.5 psi pressure pulses at the fenceline, Class III facilities will be sited in accordance with:

$$D_2 = 60\ W^{1/3}$$

Thus, a magazine containing 1,000 lb of H.E. would need to be:

$$D_2 = 60\ (1000 \times 1.3)^{1/3}$$

$$= 60\ (1300)^{1/3}$$

$$= 60\ (10.91)$$

= 655 ft from the nearest fenceline.

(Fragment distance criteria is considered separately.)

These above examples are typical of applications at Mound. Because most of our development and production deals with small explosive components, 10 lb of H.E. is about the maximum amount of H.E. that we would accumulate in one operation. Also, the newest large magazines at Mound contain less than 2,000 lb of H.E., so the above examples are realistic ones for Mound.

Because most of our components are in gram quantities of H.E., we can afford certain luxuries in our explosives safety criteria. The fenceline criteria above is one example. Other examples are the stringent criteria we impose to protect our personnel. Thus, we use $D_3 = 50\ W^{1/3}$ for our inhabited building criteria, unless the "receivers" have no windows facing the explosives operation.

We also design our walkways so that personnel will not be knocked down if there is a accidental detonation. The logic here is that an explosive worker may be carrying small explosive components in an open tray in explosive exclusion areas. If that worker is knocked down, he may spill explosives, potentially causing them to detonate. This may be similiar to a military 5 psi exclusion area, depending on charge weights (impulse).

For still another example of MRC policy, we don't want our workers to be exposed to noise levels exceeding OSHA guidelines (140-db impulse) for intentional test detonations. Also, we design plastic (Lexan or equal) barricades for as many operations as can be practically barricaded from the worker.

A PROJECT EXAMPLE OF MOUND SAFETY DESIGN CRITERIA

To illustrate some of the many environmental and safety reviews of the design of an explosive facility at Mound, I have selected our new Component Test Facility (CTF) as an example.

The CTF has been designed and, at this writing, is being built to destructively test (detonate) up to 10 lb (TNT equivalent) H.E. in totally containing test cells. This 34,000 square foot facility is shown in Figure 1. The facility contains 3 large steel test cells, 15 ft in diameter and 24 ft long. The shells are 1-3/4 in. thick and lined to absorb the shock of repeated test shots. Each test cell exhausts into an expansion chamber containing more than twice the volume of the test cell. For large shots, the expansion chambers are interconnected and a total expansion volume approximately seven times the test cell volume is available.

Camera rooms surround each test cell, and high-speed cameras photograph test shots through windows in the test cells.

On the explosives processing side of the building are test control rooms and explosive preparation areas. The preparation areas are designed to vent to the rear of the building any accidental detonations during preparation or handling.

ENVIRONMENTAL EVALUATION

All major construction projects at Mound are evaluated for any potential environmental impact. The initial evaluation is called an Action Description Memorandum (ADM), and is submitted to DOE. They may decide a more in-depth study (up to an Environmental Impact Statement) is required. The appropriate environmental documentation is finally prepared, reviewed, and approved by DOE. For the CTF, the ADM, which addressed issues like disposal of waste H.E. and ventilation control, was adequate.

SYSTEM SAFETY STUDY

To ensure that all safety features were well planned for the CTF, Mound's system safety function in a group called Loss Prevention and Environmental Control (LP & EC) recommended and coordinated a Hazard and Operability Study (HAZOP), which is a popular system safety study technique in the chemical industry.

During a HAZOP, each step in a process is reviewed. In the case of the CTF, the test process was studied. This study is documented and the recommendations are incorporated into the design of the facility.

Several design and operating safety recommendations were generated during the CTF HAZOP. However, a very important product of the process is the comfortable feeling, generated by the study process, that many involved personnnel (nine for the CTF) have thoroughly analysed the process. All major safety issues are covered, and all participants become better acquainted with the process. Thus, during future design reviews, the HAZOP participants have a good understanding of the project sponsor's needs.

In the case of the CTF, the HAZOP was performed after the safety review of the Conceptual Design Report and prior to the review of the Design Criteria Document. The design criteria is used by the architect and engineering design company to generate the final design of the facility.

SAFETY ANALYSIS REPORTS (SAR)

An SAR is a formal safety review documenting an in-depth analysis of a major explosive facility (such as the CTF). DOE Order 5481.1A provides a detailed outline of the SAR procedure and processes. The preliminary SAR (PSAR) for the CTF was submitted and generally approved prior to release of funds by the DOE. The final SAR (FSAR) will be authorized by DOE prior to facility start-up. At this writing, that is still several fiscal years away. SAR's contain 19 prescribed chapters of detailed analysis. The analyses range from accident analysis through environmental and waste management programs to a plan for decommissioning the facility.

A major benefit of the PSAR process for our CTF was the decision to make the explosive corridor in the middle of the CTF into a tornado shelter. Since this corridor was already reinforced for explosive processing, adding heavy doors to the ends of the central corridor made an inexpensive tornado shelter.

LOSS PREVENTION AND ENVIRONMENTAL CONTROL (LP & EC)

All of the safety analysis functions described herein are performed under Mound's LP & EC umbrella. The LP & EC Project Administrator reviews any potential project losses and environmental issues.

All major designs are thoroughly reviewed by a team of LP & EC resource personnel at each project milestone. Further, once the processes become operational, they are reviewed periodically (at approximately 3 year intervals), or when major process changes occur. This review process remains active until a process/facility is decommissioned. This we call our "cradle to grave" LP & EC coverage.

As this review process is applied repeatedly, standardized facility design techniques evolve. Explosive safety criteria is generated by the LP & EC during the design/concept review process. This criteria is inserted into the design criteria documents which are approved by Mound's managing directors.

To assist us in explosive facility design, we recently contracted several specialist A&E/consulting firms, under blanket contracts to generate and review designs. These firms may even help write SAR's and some of the other documentation discussed earlier in this presentation.

SUMMARY

Monsanto Research Corporation operates Mound for the Department of Energy in Miamisburg, Ohio. MRC operates, and is building more, explosive process facilities at Mound. Most of the design standards incorporated into new explosive facilities are Department of Defense standards. The principal design standards are listed in the DOE Explosives Safety Manual (DOE/EV/06194-2).

Because Mound produces small explosive components at a relatively small plant site in a densely populated area, explosive design criteria are more stringent than the DOE standard, especially for fenceline, facility explosive clearances, employee knock down, and employee noise exposure criteria.

Monsanto's Loss Prevention and Environmental Control system has been in place for several decades. The system has led Mound to achieve a world's safety record for chemical laboratories (over ten years without a lost work day case).

The ultimate objective of all explosive safety design, and any other loss prevention, environmental control, health, or safety technique and program is the reduction of human suffering. To that end, Monsanto and all DOD Explosive Safety Board meeting attendees remain dedicated. That is why we develop our explosive facility standards, and that is why we attend these meetings. It is hoped that there are some useful criteria here for others, as we all remain ever diligent to advance our profession. It is a growth process, in which I feel privileged to be constantly learning.

APPENDIX

FIGURE 1 - C. T. F.

VUE-GRAPHS USED FOR VERBAL PRESENTATIONS

COMPONENT TEST FACILITY MRC—Mound

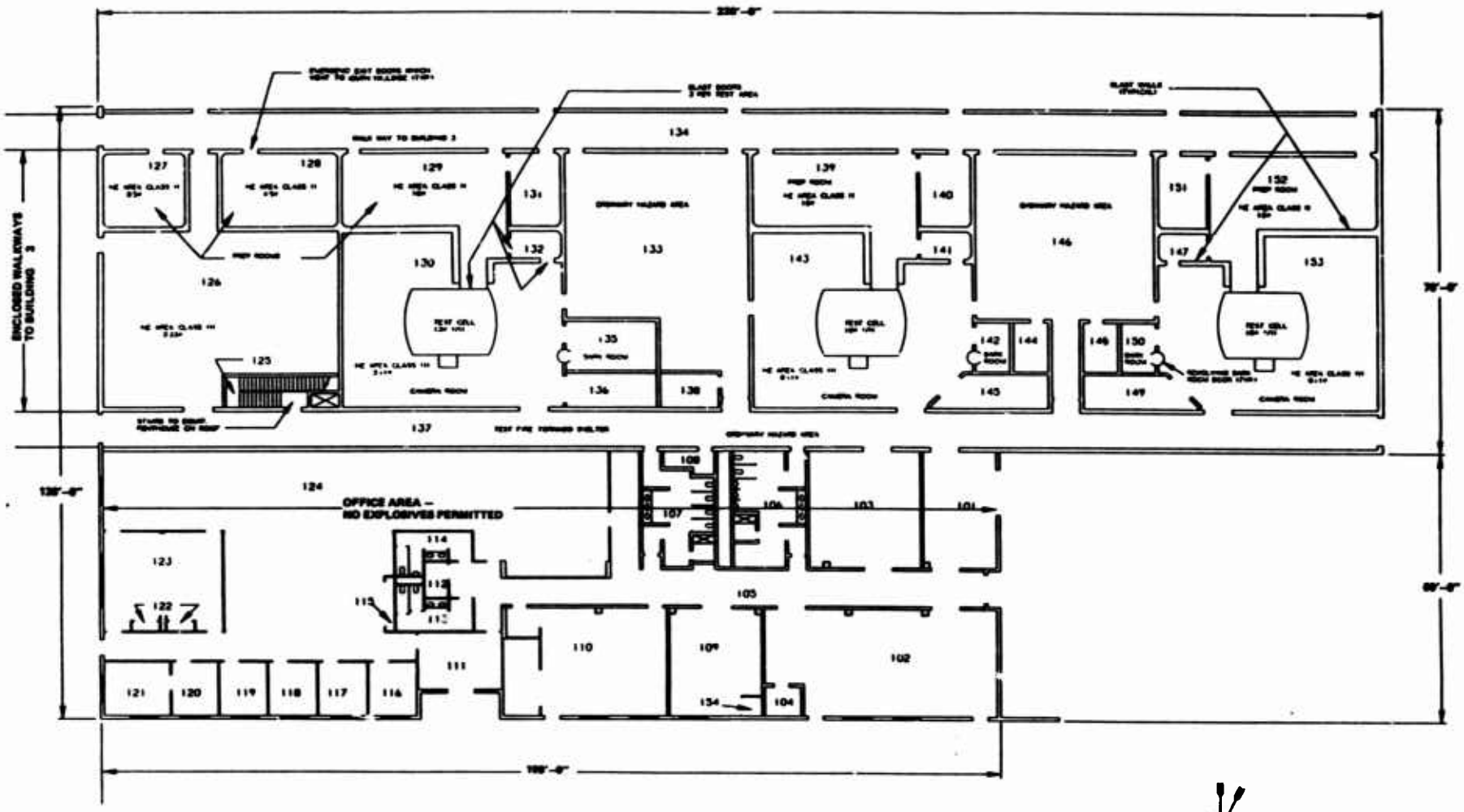

FIGURE 1

EXPLOSIVE SAFETY CRITERIA AT A DEPARTMENT OF ENERGY CONTRACTOR FACILITY

FRED KRACH, P.E.
MONSANTO RESEARCH CORPORATION

AUGUST 30, 1984

FOR
DOD EXPLOSIVE SAFETY BOARD
21ST SEMINAR

MONSANTO RESEARCH CORPORATION (MRC) EXPLOSIVE SAFETY CRITERIA IS SIMILAR TO DOD CRITERIA

- *DOE STANDARDS*
- *MRC IS MORE STRINGENT*
- *PROJECT EXAMPLE*
- *MRC'S LOSS PREVENTION AND ENVIRONMENTAL CONTROL SYSTEM*
- *STANDARDIZED FACILITY DESIGN (DOD/DOE)*

DEPARTMENT OF ENERGY (DOE) EXPLOSIVES STANDARDS

1436

- *DOE EXPLOSIVES SAFETY MANUAL (DOE/EV/06194-2)*
- *DOD STANDARDS INCORPORATED INTO DOE STANDARDS*

DOE EXPLOSIVES SAFETY MANUAL

- *HISTORY*
  - *COMMITTEE*
  - *PROPOSED SUB-COMMITTEE*
- *LIVING DOCUMENT*
  (2 MEETINGS PER YEAR)

MRC IS MORE STRINGENT THAN DOE

- *NEIGHBOR SENSITIVITY*
  - *MRC FENCELINE CRITERIA*
- *SMALL COMPONENTS*
  - *NO KNOCK-DOWN CRITERIA*
  - *NOISE CRITERIA (OSHA)*

MRC FENCELINE CRITERIA

- *CLASS I & II OPERATIONS P_S = 0.2 MAX*
  - *THRESHOLD OF HEARING SHIFT D = 100 $W^{1/3}$*
- *CLASS III OPERATIONS P_S = 0.5 MAX - BREAK WINDOWS D = 60 $W^{1/3}$*

MRC EXPLOSIVES FACILITY DESIGN DEVELOPMENT

- *COMPONENT TEST FACILITY (CTF)*
  - *ENVIRONMENTAL STUDY (ADM)*
  - *HAZOP*
  - *PSAR/FSAR*
  - *LOSS PREVENTION & ENVIRONMENTAL CONTROL REVIEWS*
- *MAGAZINES*
- *TEST CELLS*
- *DETONATOR STORAGE FACILITY/BUILDING 72*

MONSANTO'S LOSS PREVENTION AND ENVIRONMENTAL CONTROL (LP&EC) SYSTEM

- *MONSANTO HISTORY OF LP&EC*
    - *CHEMICAL INDUSTRY*
- *DESIGN REVIEWS*
    - *EXPLOSIVE FACILITIES*
        - *SUB-CONTRACTORS WITH EXPLOSIVE EXPERTISE*
- *PROCESS REVIEWS*
- *SYSTEM SAFETY (HAZOP, FAULT TREE, ETC.)*

SUMMARIZING KEY SAFETY CRITERIA ISSUES

- *DOE USES MUCH DOD CRITERIA*
- *MRC MORE STRINGENT THAN DOE*
  - *NEIGHBOR SENSITIVITY*
  - *CHEMICAL INDUSTRY*
- *SMALL COMPONENTS*
- *FENCELINE CRITERIA*
- *NOISE CRITERIA*
- *NO KNOCK DOWN CRITERIA*

OBJECTIVE OF EXPLOSIVE SAFETY — REDUCE HUMAN SUFFERING